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Planktonic foraminiferal zonation of Mid-Cretaceous of the Annopol anticline (Central Poland)

By

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With 2 text figures and 2 plates

ABSTRACT

In the Middle Albian to Turonian deposits cropping out in the Middle Vistula River valley the assemblage of 27 species of planktonic foraminifera makes possible to distinguish foraminiferal zones using the slightly modified zonal scheme as proposed by ROBASZYNSKI and CARON (1979). In the Middle Albian to Middle Cenomanian deposits the following zones have been stated: *Rotalipora appenninica* zone, *Rotalipora brotzeni* zone and *Rotalipora cushmani* zone, but because of stratigraphical condensation and faunal mixing it is not possible to draw boundaries between those zones. The *Dicarinella* spp. zone comprises the uppermost Cenomanian and Lower Turonian and it contains two subzones: *Whiteinella archaeocretacea* subzone and *Praeglobotruncana helvetica* subzone. The Upper Turonian deposits belong to the *Marginotruncana coronata* zone.

KURZFASSUNG

In den Mittel-Alb- bis Turon-Ablagerungen, die im mittleren Vistula-Flußtal aufgeschlossen sind, ermöglichen die vorkommenden 27 Arten von plantonischen Foraminiferen eine Zonierung, die etwas vom Zonierungsschema, wie es ROBASZYNSKI & CARON (1979) gegeben haben, abweicht. Vom Mittelalb bis zum Mittelcenoman werden folgende Zonen aufgestellt: *Rotalipora appenninica* Zone, *Rotalipora brotzeni* Zone und *Rotalipora cushmani* Zone. Aufgrund einer stratigraphischen Kondensation und Faunenvermischung ist es nicht möglich, Grenzen zwischen diesen Zonen zu fixieren. Die *Dicarinella* spp. Zone umfaßt das oberste Cenoman und das Unterturon; sie enthält zwei Subzonen: *Whiteinella archaeocretacea* subzone und *Praeglobotruncana helvetica* Subzone. Die oberturonen Ablagerungen gehören zur *Marginotruncana coronata* Zone.

INTRODUCTION

Mid-Cretaceous deposits of the NE Mesozoic margin of the Holy Cross Mts form an anticline in the Annopol region (Fig. 1) that was discovered by SAMSONOWICZ (1925). The deposits have been studied by numerous workers from petrographical, stratigraphical and paleontological points of view. The review of those studies may be found in my earlier paper (PERYT 1980). The present study completes and modifies previous proposed foraminiferal zonation of the Cenomanian and Turonian (PERYT 1980).

Fig. 1. Simplified map of distribution of Cretaceous deposits in the Middle Vistula River Valley (after CIEŚLIŃSKI, 1976).

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LITHOLOGY AND DISTRIBUTION OF FORAMINIFERA

ALBIAN

The Albian deposits of the Annopol anticline are about 6 m thick. They are sands and sandstones and – in the uppermost part – phosphorite deposits about 40 cm thick, separated by a thin sand layer into 2 parts: so-called lower sandy phosphorites and upper sandy phosphorites. CIEŚLIŃSKI (1959) included these deposits into his A_2–A_8 horizons (= Middle and Upper Albian). Foraminifera occur in the phosphorite layers which CIEŚLIŃSKI (1959, 1976) included into A_5–A_8 horizons (*Hoplites dentatus – Stoliczkaia dispar* zones in the ammonite subdivision). The deposits originated under conditions of very

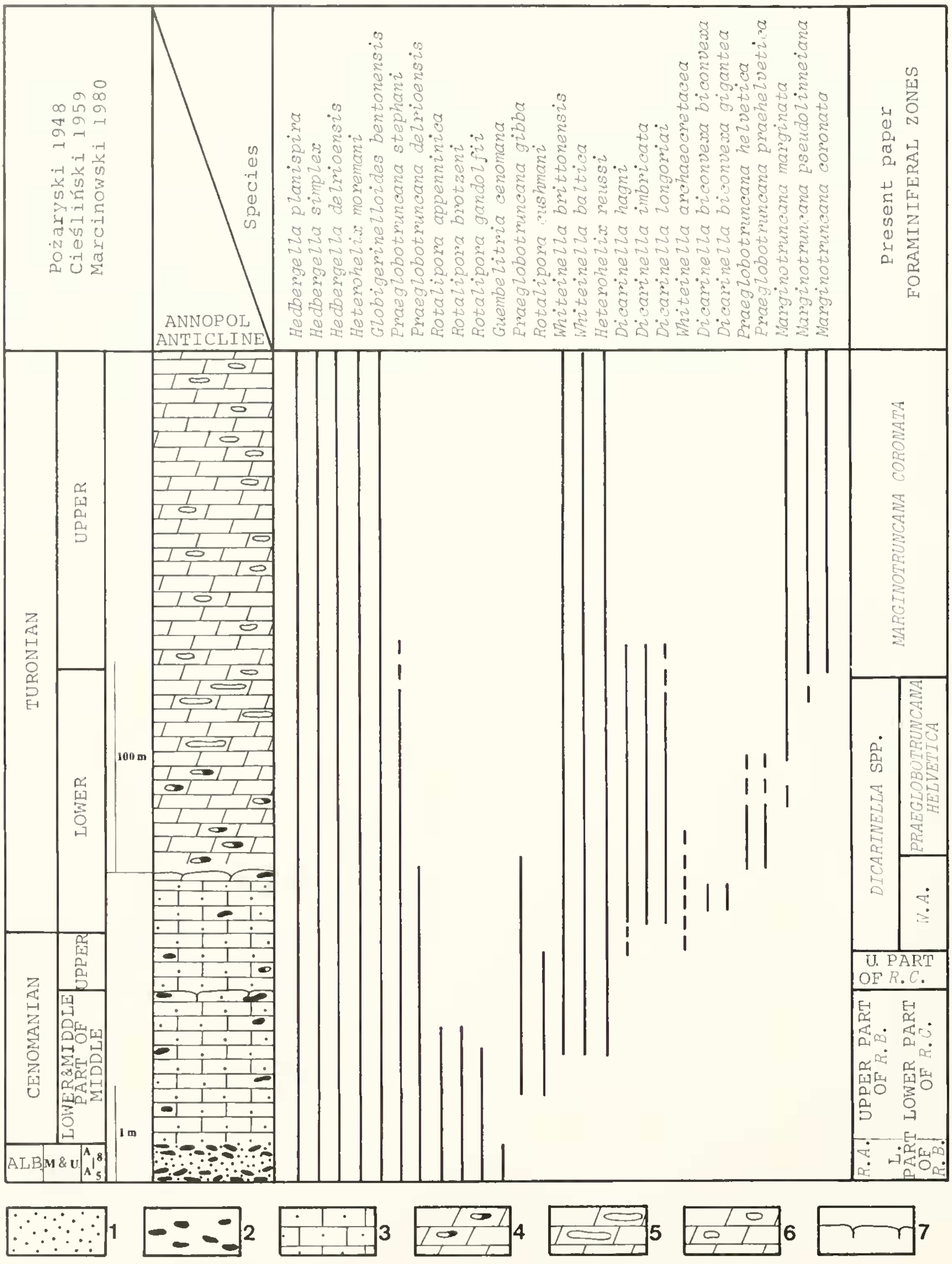

Fig. 2. Distribution of planktonic foraminifera in the Middle Albian-Turonian deposits in the Middle Vistula River Valley; 1 – sands, 2 – phosphorites, 3 – marls, 4 – opokas with chert concretions, 5 – opokas with platy cherts, 6 – opokas with cherts of irregular shape, 7 – hardground; R. A. – *Rotalipora appenninica;* R. B. – *Rotalipora brotzeni;* R. C. – *Rotalipora cushmani;* W. A. – *Whiteinella archaeocretacea.*

slow sedimentation, and therefore stratigraphical condensation may be observed, as expressed by cooccurence of the Middle and Upper Albian fossils (Cieśliński 1976). The assemblage of planktonic foraminifera from the Middle and Upper Albian phosphorites is rather poor. It consists mainly of species belonging to *Hedbergella (H. planispira, H. delrioensis, H. simplex)* and *Guembelitria cenomana, Globigerinelloides bentonensis* and *Heterohelix moremani* (Fig. 2). They are long-living species, appearing in Middle Albian and are of small stratigraphical importance. Besides, stratigraphically important species *(Rotalipora appenninica, R. brotzeni, R. gandolfii)* occur, although in small amount. The analysis of stratigraphical ranges of those species in areas of normal sedimentation and the comparison of their ranges with those of ammonites in the phosphorites of Annopol anticline also confirms the assumed stratigraphical condensation, expressed among others by the mixing of fauna of different ages. *Rotalipora appenninica* is known starting from the *Stoliczkaia dispar* zone (cf. Robaszynski & Caron, 1979) and *Rotalipora brotzeni* and *R. gandolfii* from the uppermost part of that zone. In the studied material those species already occur in the lower sandy phosphorites together with *Hoplites dentatus*. Such cooccurence is only possible in the case of mixing of fauna of different ages.

CENOMANIAN

The Albian phosphorites are overlain with sedimentary continuity by Cenomanian sandy glauconitic marls with phosphatic concretion (Cieślinski 1959, Marcinowski 1980). There occurs a layer of phosphatized marls forming concretions of nodular habitus 180 cm above the Albian/Cenomanian boundary; this is the hardground. Sandy glauconitic marls (0,5 m) occuring above it also belongs to the Cenomanian (Pozaryski 1947, 1948, Cieślinski 1959, 1976, Marcinowski 1980).

Marcinowski (1980) also stated the stratigraphical condensation in the Cenomanian. Cooccurence of ammonites characteristic of different ammonite zones in the Cenomanian up to the hardground made possible (Marcinowski 1980) to assign the condensed sequence to the Lower to middle Middle Cenomanian. The hardground is related to the stratigraphical gap comprising the *Acanthoceras jukesbrownei* zone (Marcinowski 1980). The layer of sandy glauconitic marls (0,5 m thick) above the hardground belongs to the Upper Cenomanian.

The almost entire assemblage of planktonic foraminifera occuring in the Middle and Upper Albian phosphorites also appears in the Lower and Middle Cenomanian marls as only *Guembelitria cenomana* disappears just above the phosphorites. The following species: *Praeglobotruncana gibba, Rotalipora cushmani, Whiteinella baltica, W. brittonensis, Heterohelix reussi* make their first appearances. All those species appear for the first time in the Middle Cenomanian (cf. Robaszynski & Caron, 1979), but because the stratigraphical condensation of deposits of Lower to middle Middle Cenomanian is well documented by the ammonites and faunal mixing, it seems that their appearance in the studied column does not indicate any time point but is rather accidental. On the other hand, the occurence of species like *Rotalipora cushmani, R. appenninica, R. brotzeni,* and *R. gandolfii* in the Cenomanian deposits below the hardground indicates the presence of *Rotalipora brotzeni* and *Rotalipora cushmani* zones (cf. Robaszynski & Caron, 1979). The lack of *Rotalipora reicheli*, known from the other places in the Cenomanian basin of Poland (Biedowa 1972) may indicate either different environmental conditions in the area studied or stratigraphical gap comprising the *Rotalipora reicheli* zone (= upper part of *Mantelliceras dixoni* zone and lower part of *Acanthoceras rhotomagense* zone). In the sandy glauconitic marls of the Upper Cenomanian *Rotalipora cushmani* still occurs and disappears below the first occurence of *Inoceramus labiatus*. The dying out *Rotalipora* is replaced by the newly appearing genus *Dicarinella*. In the Annopol region it is represented by the following species: *Dicarinella imbricata, D. hagni, D. longoriai, D. biconvexa biconvexa* and *D. biconvexa gigantea*.

TURONIAN

The Turonian deposits, conformably overlying the Upper Cenomanian marls, are 220 m thick in the Middle Vistula River Valley. There is no change in lithofacies at the Cenomanian/Turonian boundary. The lower part of the Lower Turonian, the *Inoceramus labiatus* zone, is developed as glauconitic marls about 1 m thick, with a hardground (Pozaryski 1948). Above the marls, white opokas with chert concretions passing into opokas with platy cherts occur. The opokas are about 100 m thick and Pozaryski (1948) includes them into *Inoceramus lamarcki* zone. In the overlying opokas, belonging to the Upper Turonian (Pozaryski 1948) the platy cherts are replaced by cherts irregular in shape.

Already in the uppermost Cenomanian, the representatives of *Dicarinella* appear; they are especially abundant in the Lower Turonian (in the bipartite division of the Turonian). In the studied material together with *Dicarinella* sp. *Whiteinella archaeocretacea* appears but it is very rare. In the lowermost Turonian the assemblage of planktonic foraminifera is dominated mostly by big forms like *Praeglobotruncana gibba, Dicarinella biconvexa biconvexa, D. biconvexa gigantea.* Two latter species have very short stratigraphical ranges in the studied section. Slightly above *Praeglobotruncana helvetica, P. praehelvetica* and *Marginotruncana marginata* appear. In the Lower Turonian, *Praeglobotruncana delrioensis, P. gibba, Whiteinella archaeocretacea* die out. Slightly later, but also in the Lower Turonian, *Praeglobotruncana helvetica* and *P. praehelvetica* (occuring rather sporadically) terminate. In the uppermost part of the Lower Turonian, *Marginotruncana coronata* and *M. pseudolinneiana* appear. In the lower part of the Upper Turonian *Praeglobotruncana stephani, Dicarinella imbricata, D. hagni, D. longoriai* die out, and in the upper Upper Turonian *Globigerinelloides bentonensis* terminates. *Marginotruncana marginata, M. coronata, M. pseudolinneiana, Hedbergella planispira, H. delrioensis, H. simplex, Whiteinella baltica, W. brittonensis, Heterohelix moremani* and *H. reussi* pass higher (Fig. 2).

Rotalipora appenninica – Rotalipora brotzeni – Rotalipora cushmani zones.

Remarks: For Upper Albian to Middle Cenomanian deposits I accept the stratigraphical scheme as proposed by ROBASZYNSKI & CARON (1979) who distinguished the following zones: *Rotalipora appenninica* zone (equivalent of almost entire *Stoliczkaia dispar* zone, without its uppermost part), *Rotalipora brotzeni* zone (equivalent of the uppermost part of *Stoliczkaia dispar* zone, and *Mantelliceras mantelli* zone, *M. saxbii* zone and lower part of *M. dixoni* zone), *Rotalipora reicheli* zone (equivalent of upper part of *Mantelliceras dixoni* zone and lowermost part of *Acanthoceras rhotomagense* zone), and *Rotalipora cushmani* zone (equivalent of upper part of *Acanthoceras rhotomagense* zone, and *A. jukesbrownei* zone, *Calycoceras naviculare* zone and lower part of *Metoicoceras geslinianum* zone). As mentioned earlier, the Middle Albian to lowermost Turonian deposits are stratigraphically condensed. One of the results is mixing fauna and therefore, by stating the presence of *Rotalipora appenninica, R. brotzeni, R. cushmani* in the deposits studied I prove the presence of the zones for which those species are index fossils, but I do not put the boundaries between the zones. The lack of *Rotalipora reicheli* in the assemblage from Annopol seems to indicate, as mentioned earlier, either unsuitable environmental conditions for this species or stratigraphical gap, comprising the total range of *Rotalipora reicheli* (uppermost Lower – lowermost Middle Cenomanian; ROBASZYNSKI & CARON, 1979). *Rotalipora cushmani* still occurs above the hardground and its last occurence marks the upper boundary of *Rotalipora cushmani* range zone.

Dicarinella spp. (partial range zone)

Definition: Interval with species belonging to *Dicarinella* contained between the last occurence of *Rotalipora cushmani* and the first occurence of *Marginotruncana coronata* (Fig. 2).

Remarks: In PERYT (1980) I included this interval into *Helvetoglobotruncana helvetica* zone. The reason of the change is because the termination of *Rotalipora cushmani* and the appearance of *Praeglobotruncana helvetica* rarely occurs in the studied area and the forms of that species are not typically developed (probably because of not the best living conditions for that species): they are smaller, their ventral sides are less convex and the keel is poorly developed. On the other hand the species of *Dicarinella (D. imbricata, D. hagni, D. longoriai)* are dominating in this interval. The *Dicarinella* spp. zone comprises uppermost Upper Cenomanian and Lower Turonian, and I distinguish 2 subzones in it: *Whiteinela archaeocretacea* subzone and *Praeglobotruncana helvetica* subzone. In most cases of modern subdivisions, those subzones are regarded as separate zones (BOLLI 1966, DOUGLAS 1969, ROBASZYNSKI 1980) but in the section examined the index species of those zones are rare and not typically developed, as mentioned above.

Whiteinella archaeocretacea subzone

Definition: Interval, with zonal marker from the last occurence of *Rotalipora cushmani* to the first occurence of *Praeglobotruncana helvetica* (Fig. 2).

Remarks: The lower boundary of the subzone coincides with the lower boundary of the *Dicarinella* spp. zone. For many years this interval has been called zone with "grandes globigerines". Besides of quite rare *Whiteinella archaeocretacea*, in the subzone abundantly occur: *Dicarinella imbricata, D. biconvexa biconvexa, D. biconvexa gigantea, Praeglobotruncana gibba* and *Whiteinella brittonensis. Praeglobotruncana helvetica* is lacking.

Age: Uppermost Upper Cenomanian and lowermost Lower Turonian.

Praeglobotruncana helvetica subzone

Definition: Interval, with zonal marker from the first appearance of *Praeglobotruncana helvetica* to the first appearance of *Marginotruncana coronata* (Fig. 2).

Remarks: The upper boundary of the subzone coincides with the upper boundary of *Dicarinella* spp. zone. The main difference in the composition of foraminiferal assemblages belonging to *Whiteinella archaeocretacea* subzone and *Praeglobotruncana helvetica* subzone is that *Praeglobotruncana helvetica, P. praehelvetica* and *Marginotruncana marginata* occur in the latter and that the species: *Praeglobotruncana gibba, Dicarinella biconvexa biconvexa, D. biconvexa gigantea* terminate in the lower part of the younger subzone.

Age: Lower Turonian except for its lowermost part.

Marginotruncana coronata interval zone

Definition: Interval with zonal marker from the first appearance of *Marginotruncana coronata* to the first appearance of *Globotruncana lapparenti* cf. PERYT 1980).

Remarks: In addition to the index species at the base of the zone *Marginotruncana pseudolinneiana* makes its appearance. In the lower part of the zone dicarinellas and *Praeglobotruncana stephani* die out and slightly higher *Globigerinelloides bentonensis* terminates.

Age: Upper Turonian–Coniacian.

FINAL REMARKS

As it is impossible to draw boundaries between foraminiferal zones in the Upper Albian to Middle Cenomanian deposits in the studied region, any indirect correlation of the deposits with their time equivalents elsewhere appears troublesome. A reliable correlation may be made in the case of Upper Cenomanian and younger deposits as the Upper Cenomanian is also stratigraphically condensed but without faunal mixing.

The Cenomanian–Turonian boundary is drawn with reference to the first appearance of *Inoceramus labiatus*.

The boundary between the *Rotalipora cushmani* and *Dicarinella* spp. zones should be drawn in the uppermost Cenomanian. The *Dicarinella* spp. zone represents an equivalent of zones comprised in interval from the last occurence of *Rotalipora cushmani* to first appearance of *Marginotruncana*, i. e. those previously usually called as the zone with "big, flat *Globotruncana*", and *Marginotruncana schneegansi* zone in Mesogean region and *Marginotruncana coronata* zone in boreal region in the newest general subdivision (Robaszynski & Caron, 1979). In the boreal region of Europe, equivalents of *Dicarinella* spp. zone of the Annopol anticline include *Praeglobotruncana* spp. zone in SE England (Carter & Hart 1977), *Whiteinella archaeocretacea* and *Praeglobotruncana helvetica* zones in Belgium (Robaszynski 1980), *Praeglobotruncana delrioensis* zone and the lower part of *Marginotruncana marginata* zone from N Germany (Koch 1977), and assemblages VI and VII described from the Lódź region of Poland (Heller 1975). In the newest general zonal scheme (Robaszynski & Caron 1979), *Whiteinella archaeocretacea* and *Praeglobotruncana helvetica* zones represent equivalent of the *Dicarinella* spp. zone.

My earlier remarks (Peryt 1980) concerning the *Marginotruncana coronata* zone remain valid. It may be added that *?Marginotruncana coronata* zone and the lower part of *?Dicarinella primitiva* zone from general zonal scheme may be treated as equivalent to *Marginotruncana* zone from the Middle Vistula River Valley.

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Plate 1

Fig. 1. *Hedbergella planispira* (TAPPAN), ×150.

Fig. 2. *Hedbergella simplex* (MORROW), ×100.

Fig. 3. *Heterohelix moremani* (CUSHMAN), ×116.

Fig. 4. *Guembelitria cenomana* (KELLER), ×150.

Fig. 5. *Globigerinelloides bentonensis* (MORROW), ×100.

Fig. 6. *Hedbergella delrioensis* (CARSEY), ×85.

Fig. 7. *Whiteinella archaeocretacea* PESSAGNO, ×60.

Fig. 8. *Whiteinella brittonensis* (LOEBLICH & TAPPAN), ×85.

Fig. 9, 10. *Rotalipora cushmani* (MORROW), 9: ×100, 10: ×85.

Fig. 11, 12. *Rotalipora appenninica* (RENZ), ×85.

Fig. 13, 14. *Rotalipora gandolfii* LUTERBACHER & PREMOLI-SILVA, ×50.

Fig. 15, 16. *Rotalipora brotzeni* (SIGAL), ×50.

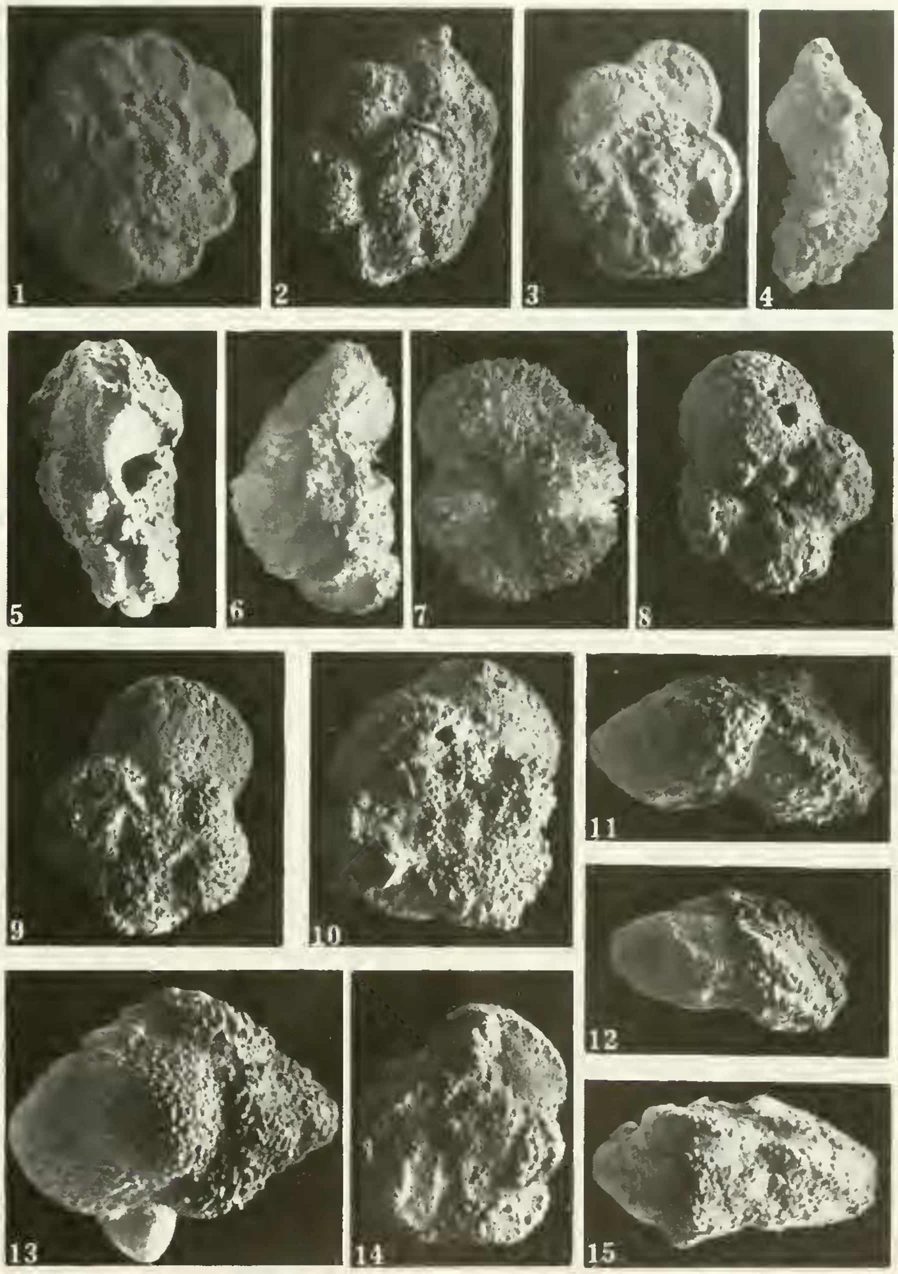
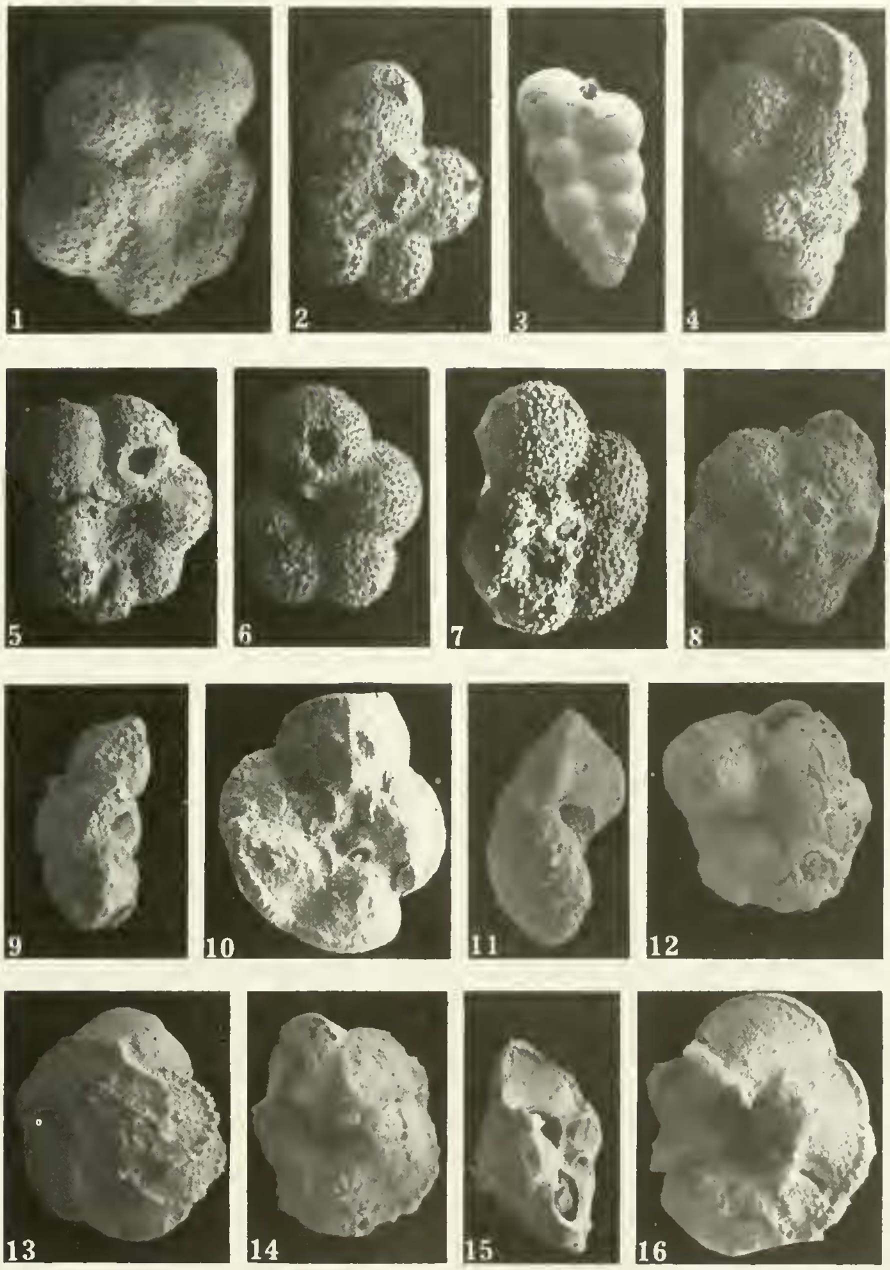


Plate 2

Fig. 1.	*Marginotruncana coronata* (BOLLI), ×40.
Fig. 2.	*Marginotruncana marginata* (REUSS, ×50.
Fig. 3.	*Marginotruncana pseudolinneiana* PESSAGNO, ×50.
Fig. 4.	*Praeglobotruncana stephani* (GANDOLFI), ×50.
Fig. 5, 9.	*Dicarinella longoriai* PERYT, ×65.
Fig. 6.	*Praeglobotruncana gibba* KLAUS, ×50.
Fig. 7.	*Praeglobotruncana delrioensis* (PLUMMER), ×65.
Fig. 8.	*Whiteinella baltica* (DOUGLAS & RANKIN), ×85.
Fig. 10.	*Praeglobotruncana praehelvetica* (TRUJILLO), ×65.
Fig. 11.	*Dicarinella biconvexa biconvexa* (SAMUEL & SALAJ), ×55.
Fig. 12.	*Dicarinella imbricata* (MORNOD), ×50.
Fig. 13.	*Praeglobotruncana* cf. *oraviensis* SCHEIBNEROVA, ×50.
Fig. 14.	*Praeglobotruncana helvetica* (BOLLI), ×65.
Fig. 15.	*Dicarinella hagni* (SCHEIBNEROVA), ×50.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